COMET CHRONOLOGY IN NUMBERS, AD 200–1882

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A satisfactory world-chronology of comets or of numerical estimates of their relative magnitude has apparently never been compiled. This is a pity both for science and history. Scientists would like very much to know whether there are other naked-eye comets, like that of Halley, whose periodic returns can be calculated and predicted[1], and historians need to know the correct dates of the bright comets often mis-dated in the chronicles.

Our own BAA catalogue[2] and our member Brian Marsden's *Catalogue of Cometary Orbits* (Smithsonian Astrophysical Observatory, Cambridge, Mass., 1972) provide standard statistics of cometary orbits so far calculated. An excellent catalogue of Far Eastern comets has been published by Ho[3] and has been supplemented for the later centuries[4]. The standard European comet-catalogues[5] (Pingré, Chambers and, recently, Baldet, 1950) are indeed full of comets, but they are too full: some 30 or more naked-eye comets are recorded in a century. This is enough to arouse suspicion. In our own day there have been few bright enough to attract attention outside astronomical circles. Indeed, there has been nothing really bright in north temperate latitudes since 1882, although a daylight comet followed by Halley's, both in 1910, and more recently Bennett's comet of 1970, were duly noted in the daily press. Yet there has not been any mysterious decline in the number or brightness of comets, which continue on their orbits as before. The inflated numbers of medieval comets occur because the standard catalogues include many which are quite unhistoric, and which, like their literary namesakes in bibliography, must be termed ghosts.

The Spectrum of Time project[6], which involved the collection and translation of all astronomical and meteorological phenomena from primary sources of different parts of the world, a project in which a number of our members are participating, is the basis of this paper. At first, it seemed that comets were going to prove even more frequent, but the use of eclipses, cold winters and other natural events, for dating purposes, soon began to show why so many comets were ghosts.

There are four reasons for unhistorical comets. The first explanation is purely astronomical. There is often a period of invisibility, corresponding but not necessarily coinciding with perihelion (the time when the comet is nearest the Sun). The chronicler sees the comet grow as it approaches the Sun, and then he watches it fade away; later he sees what he takes to be another comet receding from the Sun. If the former appearances are at dawn and the latter are at dusk, the deception is readily understood. Indeed, until he was corrected by the Astronomer Royal in 1680, even Newton was deceived in this way. The Lucerne artist in his chronicle portrayed the morning and evening apparitions

of the 1472 comet as two separate simultaneous comets. A good historical example is probably Bede's comet of 729, described as follows:

> 'In the year of our Lord 729, two comets appeared about the sun to the great terror of the beholders. One of them went before the sun in the morning at its rising; the other followed it in the evening at its setting, as if presaging dire destruction both to the east and to the west; or assuredly one was the forerunner of the day, the other of the night, to signify that mortals were threatened with calamities at both times. They carried their torch of flame towards the north, as if it were ready to kindle a fire; they appeared in the month of January, and continued for nearly two weeks.'[7]

The description given by the Venerable Bede is interpreted by astronomers as referring to a single comet with a right ascension not greatly different from the Sun, but with a high north declination. Incidentally, although this comet is referred to in a continental chronicle (*Annales Weissenberg*), and in Byzantium by Leo the Isaurian[8], it is one of the last naked-eye comets to be omitted in the Chinese and Japanese catalogues. Four appearances, separated by periods of invisibility, can occasionally be explained by a single comet.

The period of invisibility near perihelion of a single comet is normally only a few weeks, and is unlikely to be longer than several months. Nevertheless, the number of years with two comets is still greater than can be explained by random distribution and, apart from errors in the chronicler's dates, certain cases may be explained by comets following one another in the same orbit, possibly because they are remnants of a broken-up comet. Whatever the explanation we have normally given only a single mark for two comets in any one year.

The second and indeed the main reason for cometary ghosts is the unreliability of the dates in European primary sources. If the same comet is dated differently in different annals, it multiplies itself by dittography. The '*English*' comet of '678', also recorded by Bede, should be redated to coincide with the '*Oriental*' comet correctly dated 676, and the various '*Irish*' comets between 673 and 677 can likewise be brought into line. The sources agree that this comet of 676 was seen between August and October; in the case of winter comets, such as 594/5, 519/20, 744/5, 867/8, 1003/4, etc., dittography is often caused by ascribing comets to each of the adjacent years.

The third reason is also historical, but it accounts especially for the comets which are invented or mis-dated in secondary sources by historians. It so happens that when Julius Caesar died there was a comet, in 44 BC, that could be regarded as conveying his soul to the heavens, but the dramatic value of comets has always been a temptation to historians, and who are almost ready to accept the dictum that Shakespeare brings into Julius Caesar (Act II, Scene 2):

> When beggars die, there are no comets seen,
> The Heavens themselves blaze forth the death of princes.

Thus, the comets of 904 and 959 were invented because biographers claimed that comets[8] were seen at the birth and death of the Byzantine Emperor Constantinus VII[9]. Later historians copied one another, but it is clear from the Far Eastern evidence that the earlier comet must have been that of 905

(May/June), and that the later one might even be that of 962. The comets of Mithridates in the second century BC cannot for similar reasons be used for certain chronology, although the Chinese evidence for comets in September 134 BC and May 119 BC would make these dates reasonable for his birth and accession[10].

The comet of 1066, as Miss Botley has recently reminded us[11], happens to fit the Norman Conquest, but the comet associated by Pliny with the battle of Salamis in 480 BC, is almost certainly one of those recorded by the Chinese in 482 BC or 481 BC. Islamic authors are not as reliable as the Chinese in their chronology, and they, too, could not resist the political import of comets. Rashid al-Din, quoted by Horace Lamb[12], tells us how, about 1262, the Mongol Emperor Hulagu's fears increased as the comet's lights diminished, but the comet did not in fact appear until 1264. As Swift[13] put it in the eighteenth century: 'Old men and comets have been reverenced for the same reason; their long beards, and pretences to foretell events'.

The fourth and final reason for the exaggerated numbers of comets in the catalogues is the simple fact that many phenomena which were called comets by the original observers were not comets at all. In addition to novae and supernovae, which we have included in our chronology, various meteoric and auroral phenomena have found their way into the catalogues and, once there, they are not readily removed in subsequent compilations.

A true comet shines away quietly like the Moon and shows no obvious motion. Night after night it tends to be seen in nearly the same place at the same time, but it usually develops a striking 'beard' or 'tail', sometimes curved and sometimes straight, and usually likened to a sword or a broom. Comets are nearly always a pale whitish-yellow. However, a comet is above all distinguished from a nova or supernova when it does eventually prove to have been moving against the background of stars. In this connection the Association's catalogue[3] (p. 6) of cometary orbits includes a comet for 1006. In this year there was a supernova that is now regarded as a radio source. However, there may be confusion with the comet of the previous autumn, a confusion which has now been resolved by the scholarly work of Goldstein and Ho[14], and the orbit of the 1005 comet might now be calculated. The various catalogues[15] of novae include many which, as Ho[3] has shown (pp. 132, 137, etc.), can be shown to have orbits.

Inasmuch as comets and novae cannot be clearly distinguished even in the descriptions of experienced Chinese observers, we have not attempted to exclude the novae from our chronology. A 'comet' which is specifically recorded as shining for a long time in the same constellation is likely to have been a true nova or supernova, but we cannot argue from an absence of information. Many of the other so-called novae must have been minor comets which were seen once only, and the brevity of the descriptions frequently suggests this.

Meteors and aurorae have been excluded from our list. Paré's well-known 1528 'comet', the illustration of which is often reproduced, is thus omitted and

Spectrum of Time comparisons show that it was an aurora. Such phenomena occur on one, or perhaps on two, nights, and are easily excluded from a catalogue of important comets, but minor Far Eastern comets with only one observer have also been excluded from our list. Nevertheless, the Spectrum of Time material from different parts of the world usually enables us to diagnose the nature of an obscure portent. An account in a single chronicle could sometimes be any one of the following: a comet, a fireball, an aurora, a meteoric display or even distant lightning. The comparison of the various accounts also enables us to determine the correct date, and to compile a chronology of those world events that we expect to find recorded in a contemporary source.

The scale of marks adopted can be interpreted roughly as follows:

9	Created terror. Remembered for generations.
8	Created consternation. Long remembered.
7	Noted as remarkable even in short annals.
6	Noted as remarkable in most chronicles.
5	Noted by most chroniclers.
4	Noted by some chroniclers.
3	Noted by at least one contemporary chronicler.
2	Not noted by the general public.
1	Noted only by experienced sky-watchers.

In general, European chroniclers from about AD 300 until the late sixteenth century noted comets with scores of 3 or more. Chinese observers noted (albeit briefly) comets with scores of 2 and often 1 as well—except in the periods 452–500, the 520s and 712/729 and 542–559. Japanese astronomers begin to record from 634 and frequently record comets of score 2, except *c.* 726–744. Korean records[16] in the *Samguk Sagi*, do not often coincide with European comets, and the dates in the first millenium AD were found to be completely fictitious. From the early eleventh century, however, Korean records are good. Byzantine records usually include comets with scores of 3 or more from AD 336 to 594/5 and from '904', recte 905 to 1106. West European sources are complete in this respect from AD 1097; previously, however, they were good only in the ninth century. It is possible that in the following periods when we are dependent almost entirely on evidence from one part of the world, some comets worthy of 3 points have been omitted:

(*a*) Pre-336 and *c.* 403/413: Chinese evidence appears to be missing *c.* 306–28 and Roman comets of *c.* 319 and *c.* 408–13 are not confirmed.

(*b*) Later fifth century: The Chinese reports are very brief (460, 461, 464/5, 467, 483, 498). Whereas the Chinese phenomenon of 467 'might have been an auroral display' (Ho[17]), the Byzantine evidence makes it clear that the comet was very bright.

(*c*) Early seventh century: All sources except China are weak in the first quarter of this century.

(*d*) Late eighth century: Chinese and Japanese sources record no comets from between 773 and 814. This period, like the period since 1910, was indeed without any bright comets as West European evidence is sufficient to rule out the possibility of comets scoring 4 or more points.

When allowance is made for additional comets in these periods of weakness, it is found that the total score in every century is about the same. This was intended, and it can neither prove nor disprove Link's[18] contention that in some centuries more comets were seen because there were less clouds. Nevertheless, Link's 'social factor' can be calculated from our results.

Islamic evidence from Egypt, Annamese evidence as given by Ho[3] and Mexican annals have been utilized for purposes of *chronology*. However, our present *scores* given are based on descriptions from latitudes 35° to 55° north. We hope therefore[19] to prepare, at least from 1490, a similar but separate list of scores for comets seen in low latitudes. Help from our members abroad would be greatly appreciated, as it is thought that there must be many records available in Spanish, Portuguese, Arabic and other languages. Information should be sent to the author at St David's College, Beckenham, Kent, BR3 3BQ.

The stellar magnitudes of recent comets can sometimes be calculated, and although the impression created by a comet can be magnified by the shape and length of a tail, there must be a rough correspondence with the scores given here. Suggestions would again be welcome, and the author, who has used the list, 1743–1909, given by Link[20], would appreciate suggestions for a continuation beyond 1883, bearing in mind that even the score of 1 represents a comet that was seen with the naked eye by a medieval Chinese astronomer. In our present list comets with a score of 1 or 2 have been excluded except where chronological confusion with a nearby brighter comet could result. The 'century totals' by definition do not include such small scores. An attempt has been made to give names to comets left unnamed in the BAA catalogue of orbits. Such additional names refer to a contemporary description rather than to the actual discoverer.

Current Research

The elements of the orbit of Halley's comet have been revised recently both in Ireland by Kiang[21] and in the USA by Brady[22], who has developed a method of continuous integration. Brady's unpublished calculations extend back to 2647 BC, and now that the dating of Chinese oracle bones can be effected by both C-14 methods[23] and by the 'horse-shoe' method of multi-variate analysis developed by Kendall[24], it seems probable that we should be able to find a record of the appearances of *c.* 1369 BC and 1295 BC. When Halley's comet is seen in the autumn it is conspicuous before perihelion and when it is seen in spring it is conspicuous after perihelion and the early observations so far assembled confirm the (usually consistent) revisions made by Brady and Kiang.

Encke's comet was formerly brighter with a longer period. It was a naked-eye comet in 1810 and has been identified from European observations back to 1786 January. Chinese records have recently been used at the Smithsonian Institution[25] to make identifications further back in time. (Personal communications from Professor F. L. Whipple and Dr S. E. Hamid.) Dr Marsden[26] has suggested that the sun-grazing comets of 1882 II and 1965 VIII were almost certainly remnants of the comet of AD 1106, February, and that possibly the 1680 comet was a remnant of that of 372 BC.

Babylonian weather diaries, being translated by Professor A. Sachs at Brown University, USA, include references to comets recorded in China and when his work appears it may be possible to extend the comet statistics backwards before 220 BC.

In this article we have included lists for two centuries only—in the ninth the Carolingian and Chinese records both need minor corrections. In the fifteenth, our searches for aurorae in a period of weak sunspot activity necessitate careful diagnosis of all phenomena given in the chronicles.

Table of Comets

Ninth Century

	817	Feb.	4	Frankish/Chinese comet
	821	Feb.–Mar.	3	Chinese Spring comet
	834	Oct.–Nov.	3	Chinese Autumn comet
	837	Mar.–Apr.	8	Halley's Comet
	838–9	Nov.–Apr.	8	Post-Halley Great Winter Comet
	840	Mar. & Dec.	(2)	Small comet/nova in China
	841	Summer	(2)	Small nova/comet in China
	841–2	Dec.–Feb.	4	Comet of Nithard
	852	Mar.	(2)	
	853	Feb.	(2)	
	864	Apr.–June	3	Frankish Spring comet
	867–8	Nov.–Spring	5	Great Winter comet
	875	June	3	Summer comet seen e.g. at Fulda
	877	Feb.–Mar.	3	Comet/nova seen e.g. in Italy
	891	May–July	5	Alfred's comet
	894	Mar.	3	Far Eastern comet

Fifteenth Century

	1402 Espec.	Feb.–Apr.	7	Orbit 44 (BAA Catalogue)
	1404	Nov.	2	Probably nova
	1407	Dec.	2	China only
(Two?)	1430	Aug.–Nov.	2	Aug.–Sept. nova? Moving in Nov.
(One?)	1431	Jan.–May	2	Good tail in May
	1432	Feb.	2	
	1433	Sept.–Nov.	5	Orbit 45. Seen e.g. at Herat
(Two?)	1439	Mar.–July	4	
	1444	Aug.	3	
	1449–50	Dec.–Feb.	3	Orbit 46
	1456	May–July	5	Halley's Comet
	1457 i	Jan.	2	Orbit 48 (P/Crommelin 28 years)
(One?)	1457 ii	June–Aug.	5	Orbit 49 Toscanelli's Comet
	1458–9	Dec.–Mar.	3	Comet seen e.g. in Korea
(One?)	1461	July–Sept.	2	(A tail in August)
	1465	Mar.–Apr.	2	
	1468	Aug.–Dec.	4	Orbit 50
	1469	Sept.–Oct.	2	Seen in Korea
	1472	Jan.–Feb.	7	Orbit 51 (Regiomontanus)
	1476 or 77	Jan.–Feb.	2	Not recorded in China
	1490–91	Dec.–Jan.	3	Orbit 52
	1499	Aug.–Sept.	2	Orbit 53
	1500	May–July	3	Orbit 54

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HALLEY'S COMET:

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5 Baldet, M. F., *Annuaire du Bureau des Longitudes pour l'an 1950*, Paris, 1949.
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6 cf. Schove, D. J., e.g. *J. Brit. astr. Ass.*, **71,** 320 (1961) and **78,** 323 (1968).

AD 729 COMET:

7 The record in the *Ann. Weissenburgenses* in the *Scriptores rerum Germanicarum* series (and *Ann. Quedlingurgenses*, *Moni. Germ. Hist. Scriptores*, III) was presumably borrowed from Bede. The Byzantine ruler Leo III (717–741), known as Leo the Isaurian, was thought by Praetorius to have referred to it. Dr C. D. Hellman in *The Comet of 1577*, New York, 1944, on pages 254 and 346 item 30 cites Praetorius whose work of 1577 is e.g. in Bristol University library. Possibly a reference was in the lost section of the work of John of Damascus.
8 AD 904–959. Emperor Constantinus (VII) Prophyrogenitus. Leo the Deacon, *Historiae*, Book I, Chap. 1, Bonn ed., p. 5, 'Therefore at the time of the birth of Emperor Constantinus (VII) Porphyrogenitus, son of Leo (VI Philosophus), for whom a hairy star (comet) was seen at his birth and death, predicting his baptism and departure from life, no proof was required to demonstrate the (comet's) influence, as this was admitted by everyone.'
9 Translation by Rodgers, R. F., *Roy. Astr. Soc. Canada J.*, **46,** 177.
10 Mithridates (VI). His birth and accession are estimated as 135 and 119 BC. Justin in his *Historiae philippicae*, XXXVII, 2, claimed: 'The heavens themselves, by prodigies, foreshadowed his future greatness. In the year of his birth, as in the year he came to the throne, a comet lasting 70 days appeared, whose brilliance seemed to enhance the whole heavens; its rising and setting lasted four hours'.
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NOVAE:

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KOREA:

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